THE UNIVERSITY OF TEXAS AT AUSTIN

REPORT ON THE

LUNAR RANGING

at

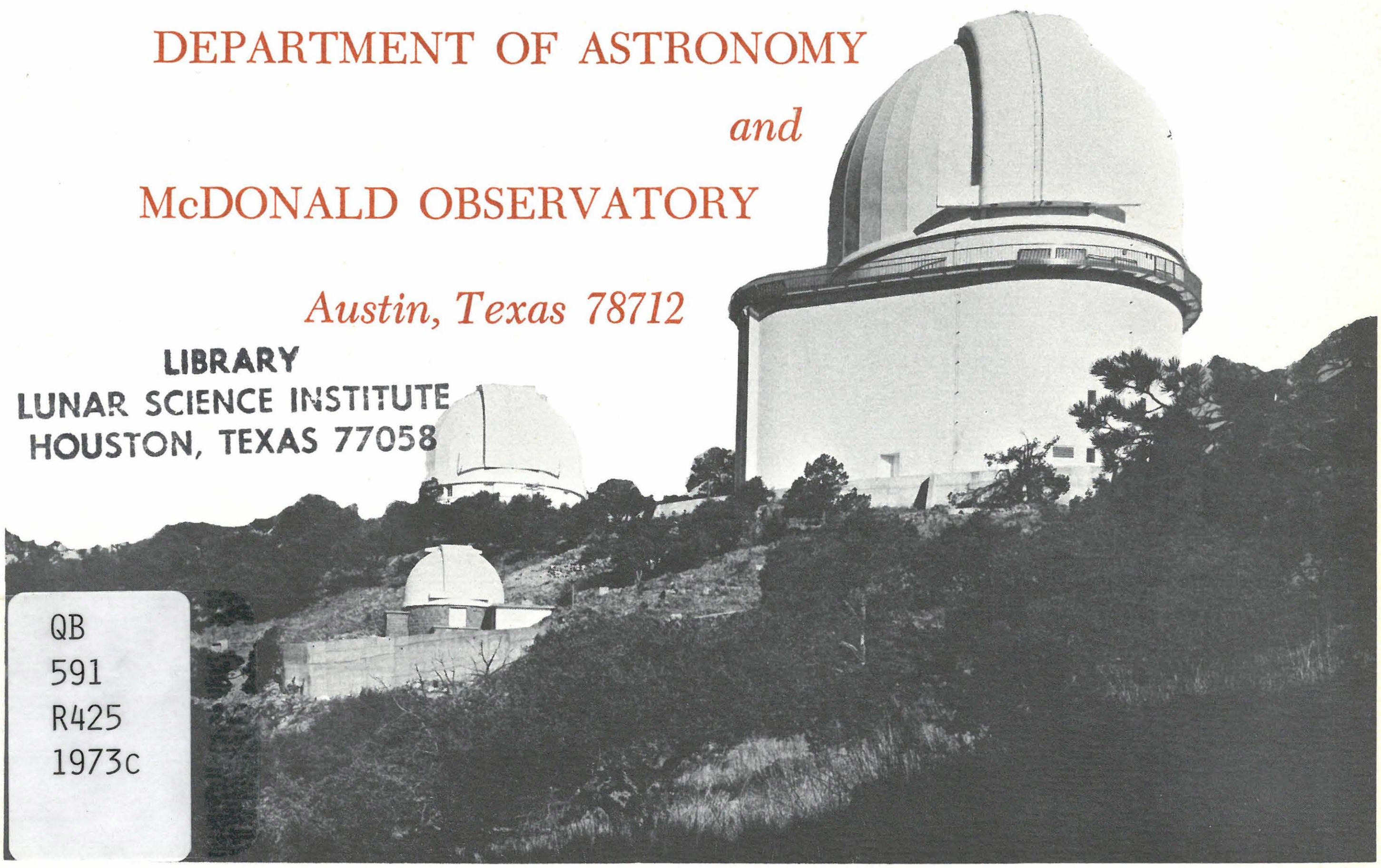
McDONALD OBSERVATORY

FOR THE PERIOD

SEPTEMBER 30, 1973 TO FEBRUARY 18, 1974*

DEPARTMENT OF ASTRONOMY
and
McDONALD OBSERVATORY

Austin, Texas 78712



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by

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and

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THE UNIVERSITY OF TEXAS at AUSTIN

Research Memorandum in Astronomy #74-004

February 1974

*This work is supported by NASA Grant NGR 44-012-165

ABSTRACT

During the five lunations from September 30 to February 18, 1974, 224 lunar ranges were obtained. In most cases the accuracy was about ± 20 cm for the first two lunations and improved to ± 12 cm during the last two lunations. The success rate was high for the entire period (90%) with a lower acquisition rate during the last two lunations because of poor atmospheric seeing and loss of some observing time to Comet Kohoutek observations.

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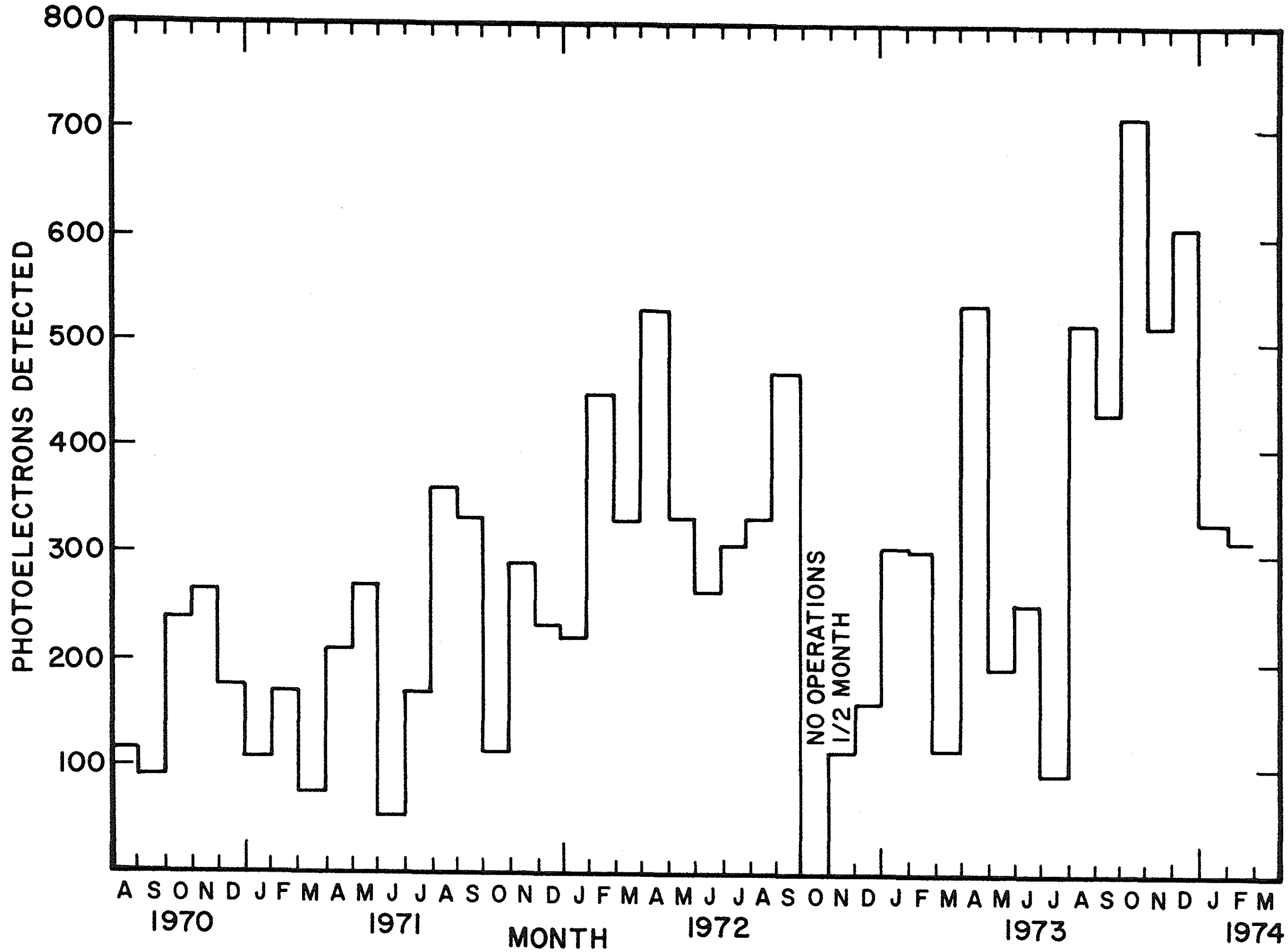
I. OPERATIONS DURING THE QUARTER

Summary: This report is one of a series of The University of Texas, McDonald Observatory documents describing the activities of the lunar laser ranging project. The reporting period covers those activities from 30 September 1973 to 18 February 1974. The following will, as usual, summarize the operations of the quarter with regard to the actual ranging to the moon as well as the systems research. In addition, it will document any anomalies in the data acquisition which pertain to possible modifications of the data reduction process.

The daily log sheets covering the operations during the reporting period are included as Appendix A of this report. In total we acquired 224 acquisitions out of 248 attempts for approximately a 90% success rate--10% better than the last reporting period. Figure 1 shows the number of return photoelectrons detected during each calendar month. The maximum number detected in any month to date was 712 in October 1973 which is the best month on record. In December 1973, 610 photoelectrons were detected with a success rate of 98%, although unfortunately the statistical accuracy of the December data was not the best because the signal in the calibration feedback was too high and variable due to progressive damage in the new He-Ne beam splitter (see Section II).

The lower number of returns in November was caused by electronics timing problems documented in Section II. Although the success rate was at the 90% level during January and February, the number of



PHOTOELECTRONS DETECTED
800
700
600
500
400
300
200
100
NO OPERATIONS
1/2 MONTH
A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M
1970
1971
MONTH
1972
1973
1974

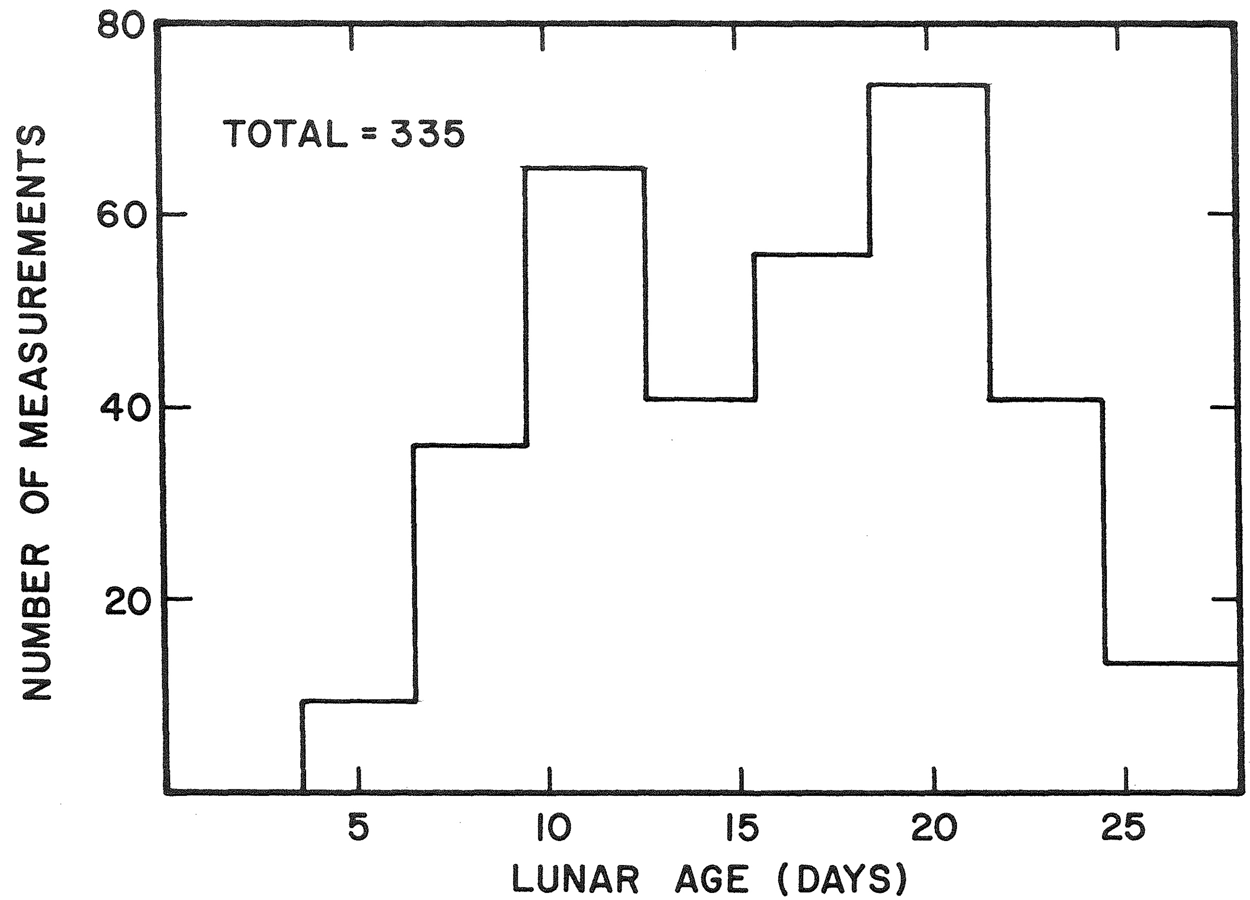
Figure 1

returns was down primarily due to observations of Comet Kohoutek during the first half of each night and generally poor seeing during both months which caused several runs to be cancelled.

Reacquisition of Lunakhod II: Acting on a report from D. Mulholland in early November that the Russians had obtained ranges on Lunakhod II during the summer months July-September, we reinstated ranging on Lunakhod II during the third quarter period in November. Reacquisition was made on November 16 with approximately a -13μ sec residual from the LURE-1 Ephemeris.

In December, three attempts were unsuccessful, possibly due to the large residual and range gate position. A solid series of ranges was analyzed by P. Shelus in Austin for a new position for Lunakhod II. Using this new position and a LURE-1 Ephemeris provided by The University of Texas Astronomy Department in Austin, we obtained five ranges in February, all within ± 200 nsecs of the predicted range. P. Shelus provided another updated position for March lunation based on all acquisitions obtained in November, January and February. Final position as of March 8, 1974 is: 30.°8549, E longitude; 25.°8420 latitude and R of 1734.757 km.

LURE -1 Ephemeris: Beginning with the November lunation the LURE-1 Ephemeris was used to generate the predicted ranges supplied by the JPL group under J. Williams. The residuals from LURE-1 were quite constant (± 100 nsec) at 0 nsec and + 300 nsec for LRRR 11 and LRRR 14 respectively. The residuals for LRRR 15 had a strong monthly signature of about 400 nsec but the range gate was quite predictable.



DISTRIBUTION OF LUNAR RANGE DATA vs SUN ANGLE
1 AUG. 1973 — 18 FEB. 1974

Figure 2

At present we have no problems at all in setting the range gate for any of the four corners.

Distribution of Lunar Ranges with Lunar Age: Figure 2 shows the distribution of ranges during the seven lunations since 1 August 1973. The distribution is good considering the difficulty in obtaining ranges in the daytime near new moon. The contrast of features, which is the primary observational problem near new moon, will be improved with the installation of the TV camera guiding systems (Section IV).

Observations of all three corners within one hour have been made on 26 occasions, primarily during the December lunation. It has been possible on two nights to do this on all three runs. This type of operation will provide data to separate various diurnal signatures. Because this type of observation requires all systems and personnel to be operating perfectly, it will be attempted only when weather, observing and scheduling conditions permit.

Comments on the Operation: The project scientist E. Silverberg relocated to Maui in early October to participate in the installation of the Hawaii station. He returned for approximately one week periods in mid-January and late February. During these periods he conducted Laser R & D connected with upgrading the McDonald system later in 1974.

The entire ranging system was quite stable until early December (see Section II, Poor Feedback Calibrations) when the new He-Ne beam splitter was installed. Primarily because of the usefulness of the calibration printout program installed in August 1973, several long-standing problems with the Astroverter circuitry were finally tracked down and solved (Section II) during November.

The policy was made that laser runs would be scheduled around the observing time when Comet Kohoutek was available for observation. Several major observing programs were planned for the 107-inch telescope, using the coude photoelectric spectrum scanner and the three interferometers at coude focus. Due to the longer periods of comet availability (three to five hours) in January and February, several of the middle laser runs were cancelled. Despite this, good coverage and 60 ranges were obtained in this period which was about the average acquisition level based on previous years' data.

II. DATA REDUCTION DOCUMENTATION

The following section lists anomalies in the operation of the experiment which resulted in adverse effects on the lunar ranging data during the last quarter. As mentioned before, the list reflects difficulties in several areas. Most of these problems are mere nuisances and have already been accounted for in the production in the data normal points. It has been our policy, however, to list all known anomalies in the event that they may later prove useful in the elimination of or possible recovery of suspect residuals.

A) Timing Problem

Symptoms (October 8): For about 10% of the legitimate timing stops the Stop vernier was not read, no range residual was calculated or typed, and the calibration residual was a constant 3.4 nanoseconds.

Explanation of Computer Program: If vernier 0 and vernier 1 are flagged but have zero magnitude at the beginning of the laser shot, the calibration residual will always be 3.4 nanoseconds since this is the value of the constant labelled "Difference in Verniers." Inspection of the output buffer revealed that vernier 0 and vernier 1 had zero magnitudes for each of the 3.4 nanosecond calibration residuals.

Also, if the magnitude of vernier 0 is zero it appears to the software that there had not been a legitimate start and therefore vernier 1 is ignored. Hence, no range residual is calculated and no residual is typed on the teletype.

Temporary Cure: It was observed that when the gate to vernier 1 was disconnected the number of non-typed stops seemed to diminish. Operating in this manner eliminates the calibration residuals.

System Improvements (October 18): It was discovered that 01 and 02 outputs of the McDonald-built Gate Isolation Circuit (the delayed TDG stretcher--Page 20, RM #72-001) were cross-coupled. This cross-coupling permitted the vernier 1 gate pulse to reach the "Inhibit the 4th AND" input of the timing AND gate. The Gate Isolation Circuit has been modified to isolate the outputs.

It was also discovered that the TDG Initial pulse was feeding through the electronic interface (RM#73-010) to the TDG Delayed cable which is connected to the "Inhibit the 4th AND" input of the timing AND Gate. Coax cables were installed to replace twisted pairs and 50 ohm loads were connected at the inputs to the electronic interface, thereby reducing the feed through to an acceptable value.

Theories Tested: The theory that the verniers were starving for a stop pulse and therefore giving a zero magnitude was investigated and found to be false. The theory that the Astroverter analog multiplexer switch controller might have been addressing an unused (and therefore zero valued) channel was investigated and found to be false.

Astroverter New Cabling (November 6): Isolated BNC's were installed on the rear panel of the Astroverter (the sample and hold, analog mux, buff amp and A/D package). The flags and signal levels from the time to pulse height converters now enter the Astroverter through these BNC's. The large-bundle, irreparable connector has been eliminated.

Problem Identified: The Astroverter Buffered Amplifier was identified as the original problem Day 317, 13 November 1973.

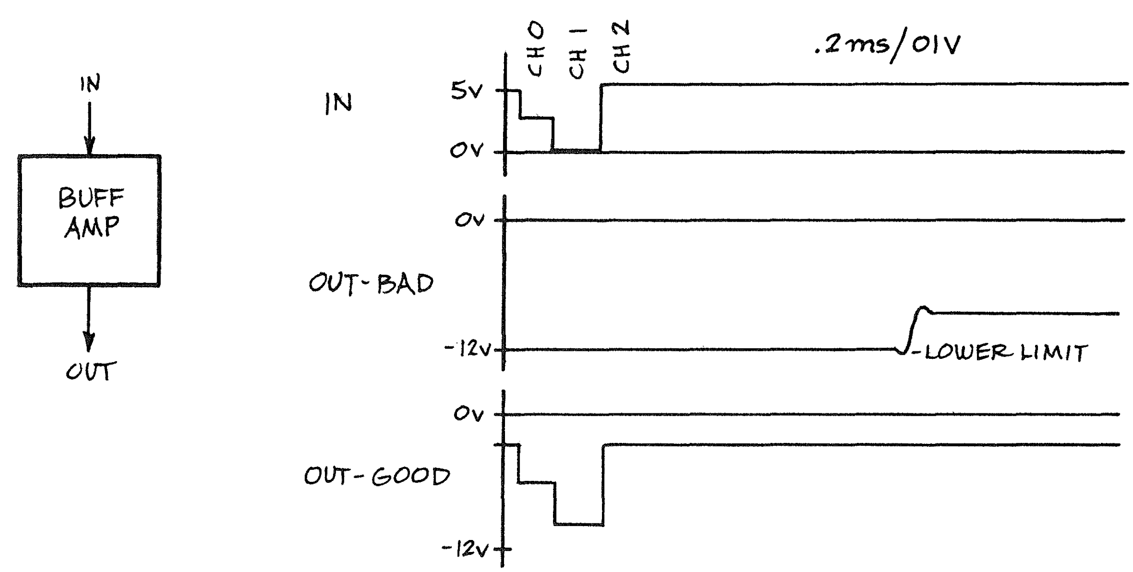
Setup: a) Delta = 0234500000

b) Normal pulser setup with the following exceptions:

1) PMT replaced with B-16 @ 400 KHz.

2) TPHC1 gated only at the beginning of shot. Gate from flip mirror signal and disconnect the cable from the delayed TDG.

Symptom: The output of the Buff Amp would not reflect the input whenever channel 1 was less than approximately 3 volts. No channel would come through the Buff Amp in this state.



Reason: Unknown. Other channels can be zero with no adverse consequences. At this writing there is no known way that address information can get to the Buff Amp.

Cure: Avoid the problem by not using channel 1. TPHC1 now goes into the Astroverter on Dat2 and Flg2. The Varian computer program has been changed accordingly.

B) Time Delay Generator Problem

Situation: The Time Delay Generator failed randomly, causing the ruby laser to shut down during runs. Sometimes there was no Delayed-TDG pulse even though there had been an Initial TDG pulse. This omission of the Delayed TDG pulse kept the flip mirror from closing and thereby generating an inhibit signal for the ruby laser.

Symptoms (Jan. 1): The TDG omitted the Delayed TDG pulse occasionally but only when the input words to the TDG were generated by the chebyshev projected range program. During normal pulser tests the TDG behaved properly. This symptom led to the discovery that whenever the unit nanosecond digit (output from the Varian computer) was a 7 the TDG would fail.

Cause: The BCD (1-2-4-8) digit from the Varian computer interface is converted to a 1-of-10 signal in the TDG. If none of the ten lines of the unit nanosecond is TRUE, no output for the unit nanosecond can be generated and therefore no Delayed TDG pulse can be generated. Apparently the section decoding the 7 is temperature-sensitive since cooling this particular circuit caused the failure to disappear. Excess heat causes the 7 line to be FALSE and therefore none of the ten lines is TRUE. The glass epoxy, copper etched, printed circuit board has been badly discolored by heat originating in the 2.2k resistors. The integrated circuits also runs very hot.

Temporary Cure: The +30 volt power to the 2.2k resistors was adjusted from +32 volts down to +30 volts. At the lower (and proper) voltage there is less heat dissipated and the TDG functions properly.

Symptom (Jan. 9): Same as above.

Cause: Excessive heat. The manufacturer's design is unsafe because it requires ten 2.2K ohm, 1/4 watt resistors to dissipate 23% more power than they can safely dissipate. Clustering of the resistors compounds the heat problem. Because of the excessive heat, seven of the 2.2K ohm resistors aged to 1K ohm (average) value. These lower-valued resistors drew more current and of course generated more heat. With the combination of a bigger load and more heat, the decoding I. C. could not pull down hard enough to output a TRUE signal.

Final Cure: The seven low-valued resistors were replaced with 2.2K ohm 1/2 watt resistors.

C) Poor Feedback Calibrations during the latter part of 1973

Problem: Freak variations in the level of the feedback light path caused the calibration system to operate much of the time with a multiphotoelectron signal. This greatly affected the accuracy of the feedback calibration for the period 1 December 1973 until 10

January 1974. A graph of the calibration data over the last few months is shown on the next page and illustrates the magnitude by which the numbers were affected (Figure 3).

Cause: The glass beam splitter used to couple the He-Ne alignment laser into the object's path was replaced in early December by a coated beam splitter designed to raise the level of the He-Ne intensity. The use of the coated beam splitter in lieu of the plain glass version raises the He-Ne intensity in the optics beam to a level where it may be observed in the guide field at full moon. This greatly increases the ability of the observer to hold the telescope on site, but the change was not without some problems. Early in the lifetime of the coated beam splitter the coating began to damage slightly, greatly increasing the intensity of the light which was fed into the feedback path. As the damage varied from night to night the feedback intensity increased to the multiphotoelectron level before the crew realized the error.

Recovery: Since the basic electronic timing system did not change from the first of August until 9 January 1974, this stability was used to recover a calibration constant for the December data which is believed to be good to approximately $\pm$ 600 picoseconds. The average calibration value for the December feedback data which corresponds very closely to the average for the September, October and November data was used for the entire month of December to determine the electronic calibration constant.

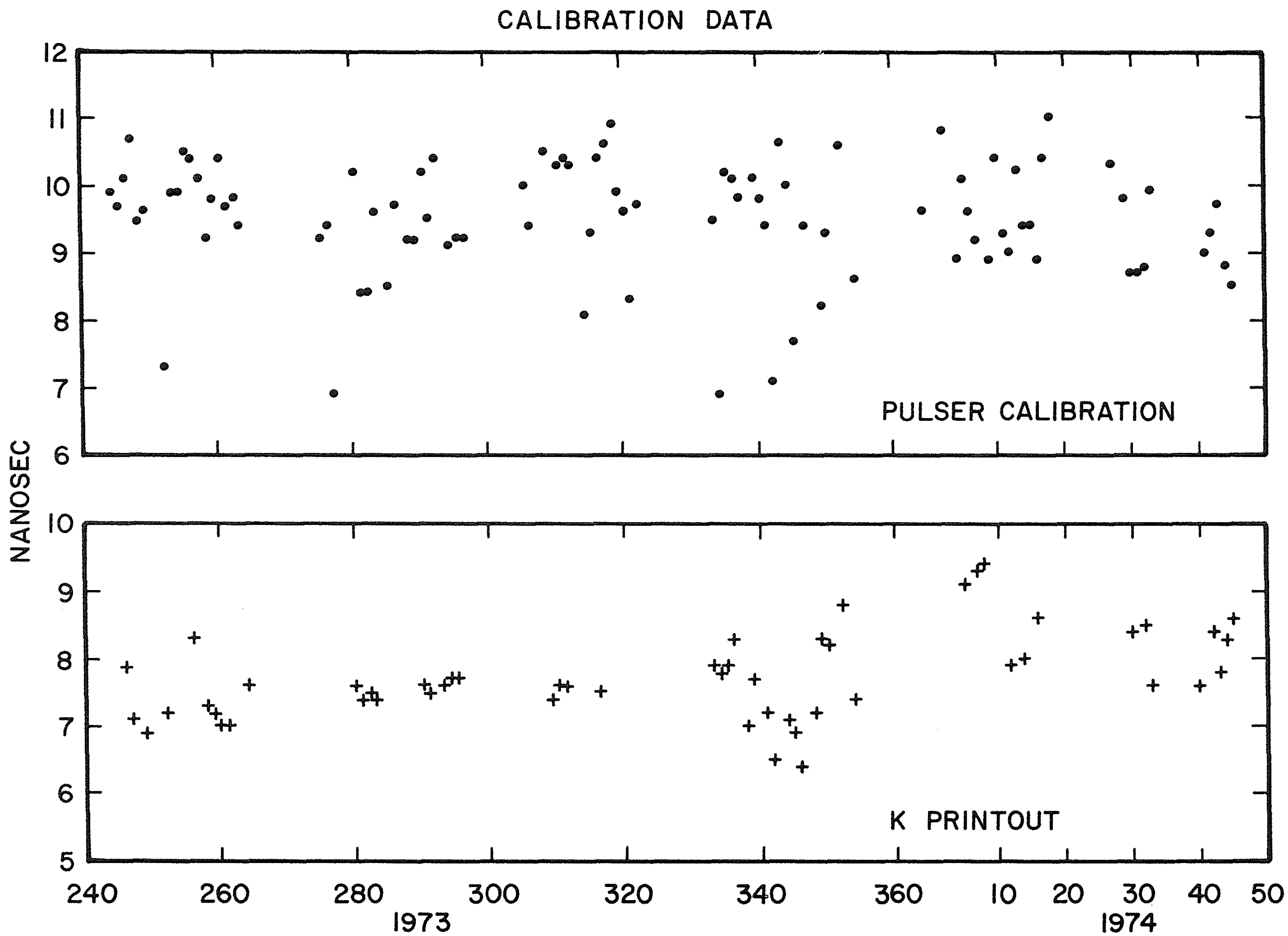

CALIBRATION DATA
NANOSEC
PULSER CALIBRATION
K PRINTOUT
12
11
10
9
8
7
6
5
240
260
280
300
320
340
360
10
20
30
40
50
1973
1974

Figure 3

Cure: Since the discovery of the problem with the feedback calibration on 10 January, the path has been operated with a great deal more attenuation to lower the intensity to well below the single photoelectron level. In addition, the beam splitter which couples the He-Ne laser into the optics path has been mounted in such a way that the component may be rotated, thus presenting a clean, undamaged surface to the outgoing laser beam whenever appreciable spotting occurred on the coating. It has furthermore been found that turning the coated surface towards the outgoing laser beam rather than away from it, as was done during December, greatly increases the lifetime of the beam splitter.

D) Possible 20 Nanosecond Timing Errors

Problem: During the filtering process conducted by the data analyzing institutions it has been noted that a number of lunar ranges now appear to deviate from the fitted ephemeris by the order of 20 nanoseconds.

Cause: It has recently been discovered that the lunar ranging timing system can generate a timing error of up to 20 nanoseconds by the interaction of the timing system with the gate pulse generated by the TDG gate isolation circuit. In the event that the timing stop occurs very close to the opening of the gate pulse, the 20 MHz timing pulses which form the basic clock frequency in our system can be modified in shape in such a way as to create a bad timing. Normally the opening of the gate pulse is not consistent enough (relative to the clock pulses in the timing system) to cause the appearance of a three or four nanosecond lunar range. The usual effect of this timing failure mode would be to mistime a number of the lunar range returns so that they would appear to be an enhanced noise level in the area of the filtered return. It does appear possible however, for such a failure mode to create a lunar range which deviates from the correct value by some 15 or 20 nanoseconds.

Recovery: Since this type of failure is related to the opening of the range gate, the value of the residual on the original plots will indicate whether or not this is a possible failure mode. Thus, it is possible to determine whether or not this failure mode could be the cause of the misfit of a particular data point, but it is not possible to say whether it in fact is the unique cause. Since this is like most of the other failure modes, it has a relatively low probability of creating the appearance of a good lunar range. The most reliable recovery is to simply eliminate these points on the basis of consistency with the neighboring data.

Cure: The present cure taken to insure the minimal effect of this failure mode is to open the range gate well ahead of the anticipated arrival of the correct timing stops. This should serve for the period of the next few months, at which time an entirely new timing system is expected to be installed at McDonald during the period of station upgrade.

III. DATA AMENDMENTS

A) Electronic Calibration Data

The following list represents changes in our estimate of the quality of the calibration data. All of the data affected was taken during the previous quarter. Override cards have been sent to the data reduction group at The University of Texas for all of the affected range measurements.

1973 Day	Elcor changed from	to
223	-76D	-76C
229	-53B	-53D
230	-48B	-48D
236	-41D	-41C
256	-54A	-54C
262	-41C	-41B
263	-41C	-41B

IV. SYSTEM IMPROVEMENTS

The Laser TV Guider System: The TV guider system for the laser focus will interface the 107-inch digital control system and a memory picture in the Varian computer of an image of the lunar surface. After an image is acquired by the TV system, any changes in contrast in selected areas of the image will cause 107-inch guiding signals to be generated to attempt to restore the image of the telescope to its original position.

The design of the hardware interface between the Reticon MC500 camera and the Varian computer depends a great deal on the software reading program. Likewise, the reading program is influenced by the hardware interface. Given the freedom to design the system from scratch, J. Wiant designed an interface which takes into account the critical parameters of data entry. Since the Varian direct-memory-access is not going to be used at the present time, data entry speed is of utmost importance. The interface does not interrupt the computer until the conversion from analog to digital signals is completed. If the camera gets ahead of the computer a hardware error signal is generated to alert the computer to ignore the last frame. In order to conserve control lines, the interface was designed to use a minimum number of external control and sense lines. Additional circuitry has been designed which detects when a 107-inch control paddle button has been pushed (and therefore the software must re-map the Reticon image).

The Reticon MC500 camera has been modified to output a video interrupt for each video signal but none during the flyback times. A pot and a switch have been added to the clock section of the camera to give variable and fast or slow integration times. A software reading program has been written which reads, stores, increments, etc. using the least number of instructions possible since the number of computer instructions is the bottleneck in the data entry speed.

He-Ne Beam Splitter: To enhance the signal from the He-Ne laser which is colinear with the ruby laser system, a dielectrically coated beam splitter was installed in the optical path at the intersection of the point of the two beams. The enhanced brightness of the He-Ne laser makes daytime and full moon alignment much easier and facilitates the visual guiding technique immensely. Unfortunately there were several problems introduced into the system by this improvement, but these have been alleviated (see Section II) and the full capabilities of the new beam splitter are now being used.

APPENDIX I

DAILY OPERATING LOG

SEPTEMBER 30, 1973 TO FEBRUARY 18, 1974

STATION LOG, OCTOBER 1973

DATE	DAY (GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Sept. 30	273	21;00				clear		cancelled for T. V. camera exp.
	274	00:00				clear	6-7	bad seeing (contrast)
Oct. 1		21:30				clear	6-7	" " "
	275	00:55	(411)	199/3	0/3	clear	2-6	
Oct. 2		21:30				clear	4-6	bad seeing (contrast)
	276	00:00	(412)	325/0	9/0	clear	3	
			(413)	47/3	9/3	clear	3	
Oct. 3		22:30	(414)	80/0	0/0	clear	3	stopped by clouds
	277	01:15	(415)	120/0	10/0	clear	3	
			(416)	269/3	0/3	clear	3	
Oct. 4	278	23:15 -03:15				cloudy		runs cancelled
Oct. 5	279	00:00-04:00				cloudy		runs cancelled
Oct. 6	280	00:50	(417)	34/3	12/3	clear	2-3	
			(418)	46/0	8/0	clear	2-3	
			(419)	68/2	19/2	clear	2-3	
			(420)	47/3	17/3	clear	2-3	
Oct. 7	281	01:00	(421)	279/3	?/3	clear	2	bad electronics problems
		03:30	(422)	170/3	51/3	clear	2	worked on electronics
			(423)	114/2	6/2	clear	2	calb. seems okay
			(424)	93/0	3/0	clear	2	" " "
Oct. 8	282	00:30	(425)	252/3	22/3	cirrus	3-5	changed channels in Asrtrav.
		04:50	(426)	332/3	14/3	clear	4-6	tests with Asrtrav.
Oct. 9	283	04:42	(427)	92/3	9/3	clear	3-4	20mi./hr. winds
			(428)	92/2	9/2	clear	3-4	" "
			(429)	181/0	12/0	clear	3-4	
			(430)	46/3	18/3	clear	3-4	
Oct. 10	284	04:30 -08:00				clear		cancelled bad seeing
Oct. 12	285	05:00				clear		cancelled-used time to work
		09:00	(431)	181/3	11/3	clear	3-4	on the electronics
Oct. 13	286	05:00	(432)	91/3	14/3	clear	2	

STATION LOG, OCTOBER 1973

DATE	DAY (GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
			(433)	327/0	0/0	clear	2	
			(434)	187/2	7/2	clear	2	
		09:00	(435)	46/3	11/3	clear	2	korad diode cable disconnected
			(436)	79/0	10/0	clear	2	" " " "
		10:30	(437)	44/3	9/3	clear	2	" " " "
Oct. 14	287	05:30-10:30				cloudy		runs cancelled
Oct. 15	288	06:30	(438)	281/3	42/3	clear	2	
			(439)	47/0	13/0	clear	2	
		09:30	(440)	52/3	17/3	clear	2	
			(441)	92/2	13/2	clear	2	
		13:00	(442)	138/3	16/3	clear	3	
Oct. 16	289	07:30	(443)	46/3	13/3	clear	2	
			(444)	140/0	10/0	clear	2	
			(445)	140/2	12/2	clear	2	
		10:30				cloudy		run cancelled
		12:00	(446)	45/3	12/3	clear	1	
Oct. 17	290	08:30	(447)	41/3	12/3	clear	2	
			(448)	186/2	10/2	clear	2	
			(449)	180/0	5/0	clear	2	
		11:30	(450)	89/3	19/3	clear	1	
		13:35	(451)	106/3	11/3	clear	1	
Oct. 18	291	09:30	(452)	47/3	23/3	clear	2	
			(453)	185/2	9/2	cirrus	2	
		11:30	(454)	86/3	10/3	cirrus	2	
		13:45	(455)	91/3	14/3	cirrus	2	
Oct. 19	292	10:00	(456)	126/2	10/2	clear	4	
			(457)	134/3	12/3	clear	4	
		12:00	(458)	234/2	11/2	clear	4	
		14:00	(459)	92/2	10/2	clear	3	
Oct. 20	293	10:50	(460)	92/2	10/2	clear	3	
			(461)	101/3	11/3	clear	3	
		13:10	(462)	90/2	9/2	clear	3	
		15:00	(463)	261/2	8/2	clear	3	poor contrast
Oct. 21	294	11:30	(464)	161/2	11/2	clear	2	
			(465)	86/3	11/3	clear	2	

STATION LOG, OCTOBER 1973

DATE	DAY (GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Oct. 21	294	13:30	(466)	45/2	12/2	clear	2	
		15:00	(467)	191/2	8/2	clear	3	poor contrast
Oct. 22	295	11:45	(468)	280/2	7/2	clear	3	
			(469)	139/3	9/3	clear	3	
			(470)	235/2	8/2	clear	3	
Oct. 23-29		NEW MOON BREAK						

Totals for October	Attempts	Successful Range Measurements
	11/0	9/0
	19/2	19/2
	30/3	27/3

STATION LOG, NOVEMBER 1973

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Oct. 30	303	19:30				clear	5-7	wind, bad seeing
		22:30				clear	5-6	wind,bad seeing
Oct. 31	304	22:00				clear	5-7	poor contrast-seeing
	305	01:30	(471)	265/0	0/0	clear	3-5	blew flashlamp
Nov. 1	305	22:00				cloudy		run cancelled
	306	02:00				cloudy		" "
Nov. 2	306	22:00				"		" "
	307	02:30				"		" "
		04:30				"		" "
Nov. 3	307	22:45				"		" "
	308	00:30				"		" "
		03:30	(472)	82/3	10/3	clear	3	testing electronics
			(473)	328/0	0/0	cirrus	2	" "
Nov. 4	308	23:30	(474)	139/3	16/3	"	2	" "
			(475)	130/2	10/2	"	2	" "
			(476)	138/0	0/-	"	2	" "
			(477)	46/3	7/3	"	2	" "
	309	05:00				cloudy		run cancelled
Nov. 5	310	00:00	(478)	123/3	10/3	clear	3	
			(479)	326/2	0/2	clear	3	
			(480)	131/3	10/3	clear	3	
		04:00	(481)	46/3	9/3	clear	3	
			(482)	397/0	?/0	clear	3	
Nov. 6	311	01:00	(483)	87/3	11/3	cirrus	3	run delayed by com-
			(484)	206/2	6/2	"	3	puter problems
		05:00	(485)	87/3	10/3	"	3	
			(486)	373/0	0/0	"	3	
			(487)	85/3	13/3	"	3	

STATION LOG, NOVEMBER 1973

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Nov. 7	312	01:00	(488)	175/3	13/3	cirrus	3	
			(489)	282/2	5/2	"	3	
		05:30	(490)	124/3	11/3	"	4-5	image motion
Nov. 8	313	01:00	(491)	143/3	12/3	"	3	
			(492)	278/0	0/0	"	3	
		05:30	(493)	44/3	13/3	clear	2	
			(494)	46/2	10/2	clear	2	
			(495)	281/0	0/0	clear	2	
			(496)	87/3	10/3	clear	2	
Nov. 9	314	01:15				cloudy	6-8	bad seeing
		05:15				fog		clouds-fog
Nov. 10	315	03:00	(497)	141/3	0/3	cirrus	4-6	stopped by clouds
		05:00	(498)	180/3	8/3	cirrus	3-4	electronics problems
Nov. 11	316	04:30	(499)	166/3	20/3	clear	2	testing electronics
			(500)	283/2	0/2	clear	2	changed sample and
		09:00	(501)	24/3	11/3	clear	2	hold cards
			(502)	25/0	10/0	clear	2	
			(503)	23/2	10/2	clear	2	
			(504)	75/3	36/3	clear	2	
Nov. 12	317	05:00	(505)	59/3	11/3	clear	2	(1800 computer pro-
		10:00	(506)	39/3	10/3	clear	2	blems)no moon file
			(507)	38/0	11/0	clear	2	
			(508)	47/2	10/2	clear	2	
			(509)	28/3	10/3			
Nov. 14	318	06:00				cloudy		run cancelled
		11:00				cloudy		run cancelled

STATION LOG, NOVEMBER 1973

DATE	DAY (GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Nov. 15	319	09:00	(510)	58/3	11/3	clear	5-7	windy
			(511)	370/4	0/4	clear	5-7	"
			(512)	37/3	11/3	clear	5-7	"
		13:00	(513)	79/3	10/3	clear	4	
			(514)	140/0	7/0	clear	4	
			(515)	222/2	6/2	clear	4	
Nov. 16	320	09:00	(516)	34/3	10/3	clear	4	
			(517)	226/4	20/4	clear	3	
			(518)	47/3	8/3	clear	3	
		13:00				cloudy		run cancelled
Nov. 17	321	09:00				cloudy		" "
		13:00	(519)	61/3	11/3	cirrus	3	
			(520)	377/4	0/4	cirrus	3	
Nov. 18	322	09:00				cloudy		
		13:30	(521)	139/2	11/2	cirrus	2	
			(522)	87/3	8/3	cirrus	2	
			(523)	47/2	11/2	cirrus	2	
Nov. 19	323	12:30				cloudy		run cancelled
		15:30				"		" "
Nov. 20	324	12:00				clear		windy-cancelled
		16:00				clear		" "
Nov. 21-28		NEW MOON BREAK						

TOTALS FOR NOVEMBER	ATTEMPTS	SUCCESSFUL RANGE MEASUREMENTS
	10/0	3/0
	11/2	9/2
	29/3	28/3
	3/4	1/4

STATION LOG, DECEMBER 1973

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Nov. 28	332	19:30				clear		Power off cancelled
		23:00	524	319/0	0/0	clear	3	
			525	417/3	7/3	clear	3	
Nov. 29	333	20:45				clear	5-7	Seeing cont. canc.
		23:15	526	140/3	8/3	clear	3	
			527	208/0	10/0	clear	3	
	334	01:00	528	95/3	11/3	clear	3	
			529	206/2	0/2	clear	3	
Nov. 30	334	20:00						Power Off cancelled
		23:00	530	140/0	10/0	clear	3	clock stopped long
			531	127/3	11/3	clear	3	power shortage
	335	02:00	532	252/0	7/0	clear	2	
Dec. 1	335	21:30				clear	6-9	cancelled seeing
		23:30	533	185/0	9/0	clear	3-5	
			534	279/3	14/3	clear	3	
	336	03:00	535	126/0	10/0	clear	3	
			536	82/3	9/3	clear	3	
Dec. 2	336	22:00	537	122/3	10/3	clear	4-6	image motion
	337	01:30	538	202/3	9/3	clear	5-7	image motion, wind
		04:00	539	140/3	13/3	clear	5-7	image motion, wind
Dec. 3	337	23:00				clear		cancelled wind
	338	02:00				clear		cancelled wind
		04:00				clear	6-8	cancelled seeing
Dec. 4	339	00:15	540	56/3	10/3	clear	3	clock stopped long
			541	81/0	10/0	clear	3	power shortage
			542	143/2	9/2	clear	3	
		03:30	543	58/3	10/3	clear	4	
			544	200/0	10/0	clear	4	
			545	190/2	7/2	clear	4	
		05:30	546	44/3	10/3	clear	4	
			547	172/0	10/0	clear	4	
			548	233/2	10/2	clear	4	
Dec. 5	340	00:00				clear		cancelled FAA
		03:30	549	27/3	11/3	clear	3	clock stopped long
			550	84/0	10/0	clear	3	power shortage
			551	144/2	8/2	clear	3	
		06:33	552	39/3	14/3	clear	3	
Dec. 6	341	00:00	553	96/3	10/3	clear	4	clock stopped long power shortage

STATION LOG, DECEMBER 1973

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Dec. 6	341	04:15	554	43/3	10/3	clear	3	
			555	84/0	10/0	clear	3	
			556	49/2	10/2	clear	3	
		07:00	557	32/3	10/3	clear	3	
Dec. 7	342	02:00	558	47/3	11/3	clear	2	
			559	68/0	11/0	clear	2	
			560	86/2	11/2	clear	2	
		05:00	561	48/3	11/3	clear	2	
			562	141/0	9/0	clear	2	
			563	67/2	11/2	clear	2	
		08:00	564	138/3	8/3	clear	3-4	
			565	328/0	8/0	clear	3-4	
Dec. 8	343	03:00				cloudy		cancelled
		06:00				clear	5-6	cancelled seeing
		09:00				clear	6-8	cancelled seeing
Dec. 9	344	03:30	566	190/3	10/3	clear	3-4	
		07:00	567	94/3	9/3	clear	3-4	
			568	188/0	9/0	clear	3-4	
			569	140/2	9/2	clear	3-4	
		10:00	570	93/3	12/3	clear	3	
Dec. 10	345	03:30				clear	7	canc. ocultation
		07:00	571	73/3	11/3	cirrus	3	
			572	121/0	11/0	cirrus	3	
			573	139/2	11/2	cirrus	3	
		10:00	574	187/3	8/3	cirrus	5	wind, image motion
Dec. 11	346	04:30	575	170/3	9/3	clear	5-7	wind, image motion
		07:30	576	47/3	12/3	clear	4	wind, image motion
			577	211/0	10/0	clear	4	wind, image motion
			578	141/2	8/2	clear	4	wind, image motion
		10:30				clear		cancelled high wind
Dec. 12	347	07:00	579	48/3	10/3	clear	4	image motion
			580	191/0	8/0	clear	4	
		10:30	581	83/3	10/3	clear	4	image motion
			582	95/2	8/2	clear	4	image motion
		13:00						cancelled, comet
Dec. 14	348	07:00						cancelled Telescope focus problems

STATION LOG, DECEMBER 1973

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
		10:30	583	97/3	10/3	clear	4	
			584	114/0	6/0	clear	4	Broken flashlamp #1 amp
		13:30						cancelled, Comet
Dec. 15	349	07:45	585	141/3	11/3	clear	4	
			586	166/4	0/4	clear	4	
		10:30	587	311/4	0/4	clear	5	
			588	142/3	9/3	clear	5	
		14:00	589	283/3	9/3	clear	4	1.2A Filter problems
Dec. 16	350	10:30	590	47/3	9/3	clear	5-8	did not shoot ref.4
							7-9	computer problems
		13:00	591	333/4	0/4	clear	4-5	
			592	212/3	9/3	clear	4-5	
		15:30	593	222/3	10/3	clear	6	
Dec. 17	351	10:30				cloudy		cancelled-clouds
		13:00					7-9	cancelled-bad seeing
Dec. 18	352	11:30	594	329/2	9/2	clear	5-8	
		13:30	595	180/2	8/2	clear	4-7	
		16:00					6-8	cancelled,Comet
Dec. 19	353	12:00					15-20	cancelled,bad seeing
		14:00					15-20	" " "
		16:00					15-20	cancelled,highwinds
Dec. 20	354	13:00	596	142/3	10/3	clear	4	
			597	144/2	9/2	clear	4	
		16:30				clear	5	very poor contrast

STATION LOG, DECEMBER 1973

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Dec. 21	355	13:30				clear	7-10	cancelled,seeing
Dec. 22-27		NEW MOON BREAK						

TOTALS FOR DECEMBER	ATTEMPTS	SUCCESSFUL RANGE MEASUREMENTS
	19/0	18/0
	15/2	14/2
	37/3	37/3
	3/4	0/4

STATION LOG
JANUARY, 1974

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Dec. 28	362	19:00-01:00				cloudy		cancelled, clouds
Dec. 29	363	20:00				clear	3-4	cancelled,poor contrast,image motion
		22:30				clear	3-4	" " " " "
		00:15	(598)	301/4	0/4	cirrus	3-4	image motion
			(599)	183/3	3/3	cirrus	3-4	stopped by cirrus
Dec. 30	364	19:00-02:00				cirrus		cancelled,cirrus,wind
Dec. 31	365	20:00				cirrus	6-8	cancelled, 1800 moon file problems
		00:30				cirrus	6-8	cancelled,poor seeing, clouds
		04:00				"		" " " "
Jan. 1	001	23:00	(1)	177/3	0/3	cirrus	3-5	T D G electronics problems
		01:00				clear		cancelled, T D G (7's)
		04:30				clear		" " "
Jan. 2	002	23:00				clear	6-8	cancelled, poor seeing, image motion
		04:30				clear	10-15	" " " " "
Jan. 3	003	23:30				clear	8-10	" " " " "
		03:30				clear	6-8	" " " " "
Jan. 4	004	23:30	(2)	242/3	10/3	clear	4	poor contrast
		04:30	(3)	86/3	10/3	clear	2	
			(4)	47/0	11/0	clear	2	
			(5)	85/2	11/2	clear	2	
Jan. 5	006	01:30-05:30				cloudy		runs cancelled, clouds
Jan. 6	007	03:00	(6)	37/3	10/3	clear	2	
			(7)	119/0	10/0	clear	2	
			(8)	49/2	13/2	clear	2	
		07:30	(9)	133/3	9/3	clear	3	

STATION LOG
JANUARY, 1974

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Jan. 7	008	04:45	(10)	100/3	10/3	clear	3	T D G stopping, overheating
			(11)	148/0	8/0	clear	3	" " "
			(12)	45/2	10/2	clear	3	T D G did not stop, used a fan to cool
		09:15	(13)	376/3	?/3	cirrus	4	image motion
Jan. 8	009	05:00-09:00				cloudy		runs cancelled, clouds,rain
Jan. 10	010	06:30	(14)	172/3	10/3	cirrus	4	stopped by clouds
			(15)	117/0	5/0	clouds	4	" " "
		10:00				cloudy		cancelled, clouds
Jan. 11	011	06:00				clear	7-9	cancelled, bad seeing, image motion
		09:30	(16)	184/3	9/3	clear	4	
			(17)	257/0	8/0	clear	4	
Jan. 12	012	07:00	(18)	228/3	29/3	cirrus	1	Disc.=170, V= 2800
			(19)	123/2	10/2	cirrus	2	uses last half of K's
		13:00	(20)	374/3	7/3	cirrus	3	poor transparency
Jan. 13	013	07:30-12:30				cloudy		runs cancelled, clouds
Jan. 14	014	09:15	(21)	431/4	3/4	ptly.cloudy	4	confirmed by second run
			(22)	138/3	6/3	" "	4	
		13:30	(23)	236/4	19/4	" "	3-4	
			(24)	101/3	8/3	" "	3-4	
		15:00				clear		cancelled, laser problems
Jan. 15	015	09:45	(25)	134/3	8/3	clear	4-6	
			(26)	261/4	9/4	clear	4-6	
		13:30	(27)	471/4	7/4	clear	4-6	
			(28)	193/3	6/3	clear	4-6	

STATION LOG
JANUARY, 1974

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Jan. 16	016	10:30	(29)	142/4	11/4	clear	3	
			(30)	144/2	9/2	clear	3	
			(31)	97/3	7/3	clear	3	
			(32)	182/4	0/4	clear	3	
		13:00				clear		cancelled, laser problems
Jan. 17	017	11:40	(33)	193/3	8/3	clear	4	
			(34)	235/2	5/2	clear	4	
		14:15	(35)	473/3	0/3	clear	4	
Jan. 18	018	12:30				cloudy		cancelled, clouds
Jan. 19-25		NEW MOON BREAK						

TOTALS FOR JANUARY	Attempts	Successful Lunar Measurements
	5/0	5/0
	6/2	6/2
	19/3	16/3
	7/4	5/4

STATION LOG
FEBRUARY, 1974

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
Jan. 26	026	19:30-00:00				clear		cancelled, high wind
Jan. 27	027	19:45-00:00				ptly. cldy	5-10	cancelled,poor contrast
Jan. 28	028	20:00				clear		cancelled, tele. problems
		22:30	(36)	615/0	8/0	clear	4	worked on feedback accuracy
		01:00				clear		cancelled forcomet(Danks)
Jan. 29	029	21:00				clear	3-4	cancelled,poor contrast
		00:00	(37)	409/0	7/0	clear	3	
			(38)	148/3	0/3	clear	3	
		03:00				clear		cancelled, for comet(Danks)
Jan. 30	030	21:00				clear	5-8	cancelled,poor seeing,cont
		23:30	(39)	285/3	13/3	clear	3	
			(40)	140/0	11/0	clear	3	
			(41)	10/2	0/2	clear	3	laser problems
		03:00				clear		cancelled, comet(Danks)
Jan. 31	031	23:30	(42)	115/3	6/3	cirrus	2	laser flashlamp#3 Amp.
		02:00				clear		cancelled,for comet(Danks)
		05:00	(43)	64/3	11/3	clear	3	
			(44)	236/0	9/0	clear	3	
			(45)	189/2	6/2	clear	3	
Feb. 1	033	00:00	(46)	105/3	11/3	clear	3	
			(47)	70/0	10/0	clear	3	
			(48)	138/2	10/2	clear	3	
			(49)	86/3	10/3	clear	3	
		03:00				clear		cancelled, forcomet(Danks)

STATION LOG
FEBRUARUY, 1974

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
		05:00	(50)	87/3	9/3	clear	3	
			(51)	85/0	10/0	clear	3	
			(52)	135/2	10/2	clear	3	bad image motion
Feb. 2	034	00:00	(53)	143/3	10/3	clear	4	bad image motion
			(54)	176/0	10/0	clear	4	
			(55)	87/2	10/2	clear	4	
			(56)	138/3	10/3	clear	4	
		03:00				clear		cancelled,comet(Danks)
		05:00				clear	6-8	cancelled,bad seeing
Feb. 3	035	00:00	(57)	274/3	7/3	clear	4-5	image motion
		03:00						cancelled, comet (Danks)
		05:00				clear	6-8	cancelled,bad seeing
Feb. 4	036	01:00						cancelled comet(Danks)
		04:30				clear	8-10	cancelled, bad seeing
		09:00				clear	8-10	cancelled, bad seeing
Feb. 5	037	02:00						cancelled, comet(Danks)
		04:30				cloudy		cancelled, clouds
		09:00				clear	2-3	cancelled, #3 flashlamp
Feb. 6	038	04:30				cloudy		cancelled, clouds
		07:00				cirrus	10-15	cancelled,seeing(net-80)tau
		09:30				clear	10-15	cancelled, bad seeing
Feb. 8	039	05:00				clear	15-20	cancelled, very bad seeing

STATION LOG
FEBRUARY, 1974

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHTS	RETURNS	WEATHER	SEEING	COMMENTS
		08:00				cloudy		cancelled, clouds
		11:00				cloudy		cancelled, clouds
Feb. 9	040	06:00	(58)	308/3	9/3	clear	4	
		09:00	(59)	342/3	5/3	clear	4	
		11:30	(60)	125/3	10/3	clear	4	
			(61)	278/0	0/0	clear	4	
Feb. 10	041	08:00				cloudy		cancelled, clouds
		11:00				cloudy		cancelled,(Planetary)Potter
		14:00				cloudy		cancelled, clouds
Feb. 11	042	08:30	(62)	181/3	11/3	clear	3	
			(63)	276/0	8/0	clear	3	
		10:30				clear		cancelled,Planetary(Potter)
		13:30	(64)	328/3	0/3	clear	4	telescope on West side
Feb. 12	043	08:30	(65)	193/4	12/4	clear	3-4	
			(66)	64/3	10/3	clear	3-4	
			(67)	114/0	3/0		3-4	blew calcite prism
		11:30				clear		cancelled, Potter
		13:30	(68)	264/4	10/4	clear	3	
			(69)	141/3	8/3	clear	3	
Feb. 13	044	09:00	(70)	369/4	9/4	cirrus	3-5	tele. tracking problems
			(71)	123/3	10/3	cirrus	3-5	
		12:30	(72)	238/3	12/3	cirrus	3-5	tele. tracking problems

STATION LOG
FEBRUARY, 1974

DATE	DAY(GMT)	TIME	RUN NO.	NO. OF SHOTS	RETURNS	WEATHER	SEEING	COMMENTS
			(73)	334/4	7/4	cirrus	3-5	
		14:30	(74)	287/3	11/3	cirrus	3-5	
			(75)	205/4	0/4	cirrus	3-5	
Feb. 14	045	12:00	(76)	333/3	5/3	clear	5	working on laser F. L. delay.
			(77)	342/4	7/4	clear	5	F. L. delay
			(78)	172/3	10/3	clear	5	F. L. delay
		16:00				cloudy		cancelled, clouds
Feb. 15	046	13:00				clear	7-9	cancelled, seeing, contrast
		15:30				clear	7-9	" " "
Feb. 16	047	13:00-15:30				cloudy		cancelled, clouds
Feb. 17	048	13:30-17:00				cloudy		cancelled, clouds
Feb. 18	049	14:30-18:00				clear		cancelled, high wind

Feb. 19-24 NEW MOON BREAK

TOTALS FOR FEBRUARY	Attempts	Successful Lunar Measurements
	10/0	9/0
	5/2	4/2
	22/3	20/3
	6/4	5/4

APPENDIX II

SYSTEM CALIBRATION DATA

SYSTEM CALIBRATION DATA

The following pages contain the calibration constants for the quarterly period covered by the present report. The categories A through E are explained below.

A - This column contains the uncorrected calibration constant for the entire lunar ranging system as measured by a light emitting diode. It is approximately 5.5 nanoseconds higher than the final calibration value due to internal delays in the photodiode as well as geometric corrections.

B - This column shows the results of calibrating only the relative delays between the photodiode and photomultiplier sides of the ranging system using a separate time-to-pulse height converter and a pulse height analyzer.

C - This column gives the arithmetic mean of the feedback calibration return through the entire lunar ranging system as recorded during the actual lunar ranging by the system teletype.

D - This column shows results of subtracting the 2.9 nanosecond geometric correction from Column C. The units have been changed to tenths of nanoseconds and a minus sign added to coincide with how this additive constant appears on the preliminary data cards. Letters A, B, C, and D follow the corrected calibration constant to indicate the relative accuracy, where: A = ± 200 picoseconds; B = ± 400 picoseconds; C = ± 600 picoseconds; and D = ± 1000 picoseconds, E = 1.0-1.5 nanoseconds.

CALIBRATION DATA
OCTOBER,1973

DATE	A	B	C	D
31,000F, V= 2750 Int.= 10, Diff.= 50 Disc.= 1.25,	G= 2			
275	9.2	--	--	-48C
276	9.4	--	--	-48C
277	6.9	--	--	-45C
278	--	--	--	--
279	--	--	--	--
280	10.2	--	7.6D	-47C
281	8.4	28.5	7.4B	-45B
282	8.4	30.0	7.5C	-46C
283	9.6	27.5	7.4C	-45C
284	--	--	--	--
285	8.5	27.5	--	-45C
286	9.7	29.0	--	-47C
287	--	--	--	--
288	9.2	28.0	--	-48C
289	9.2	29.0	--	-48C
290	10.2	28.5	7.6D	-47C
291	9.5	--	7.5C	-46C
292	10.4	--	--	-47C
293	9.1	--	7.6D	-47C
294	9.2	--	7.7D	-48C
295	9.2	28.5	7.7B	-48B

CALIBRATION DATA
NOVEMBER,1973

DATE	A	B	C	D
31,000F, V= 2750 Int.= 10, Diff.= 50 Disc.= 1.25, G= 2				
303	--	--	--	--
304	--	--	--	--
305	10.0	28.0	--	-47D
306	9.4	--	--	--
307	--	--	--	--
308	10.5	28.0	--	-47D
309	--	--	7.4B	-45B
310	10.3	27.0	7.6B	-47B
311	10.4	28.0	7.6B	-47B
312	10.3	--	--	-47D
313	--	26.0	--	-46D
314	8.1	--	--	--
315	9.3	--	--	-46D
316	10.4	28.0	7.5C	-46C
317	10.6	--	--	-46D
318	10.9	--	--	--
319	9.9	26.0	--	-46D
320	9.6	--	--	-46D
321	8.3	28.0	--	-45D
322	9.7	27.0	--	-47D

CALIBRATION DATA
DECEMBER, 1973

DATE	A	B	C	D
31,000F, V= 2750 Int.= 10, Diff.= 50 Disc.= 1.25, G= 2				
332	--	--	--	--
333	9.5	26.0	7.9C	-46C
334	6.9	26.5	7.8C	-46C
335	10.2	27.5	7.9B	-46C
336	10.1	27.0	8.3C	-46C
337	9.7	--	7.0B	-46C
338	--	--	--	--
339	10.1	27.0	7.7B	-46C
340	9.8	--	--	-46C
341	9.4	26.5	7.2B	-46C
342	7.1	26.5	6.5A	-46C
343	10.6	--	--	--
344	10.0	27.0	7.1B	-46C
31,000F, V= 2700, Disc.= 1.25, Int.= 10, Diff.= 50, G= 2				
345	8.7	26.0	6.9B	-46C
346	--	--	6.4B	-46C
347	9.4	--	--	-46C
348	--	--	7.2C	-46C
349	8.2	--	8.3B	-46C
350	9.3	--	8.2A	-46C
351	--	--	--	--
352	10.6	--	8.7A	-46C
353	--	--	--	--
31,000F, V= 2750, Disc.= 1.25, Int.= 10, Diff.= 50, G= 2				
354	8.6	--	7.4B	-46C

Comment on December Calibration Data:

The December calibration data is unusually variable due to difficulty maintaining a constant light level in the feedback path. This caused confusion in the automated computer reduction program, which creates the numbers in column C. Thus, instead of using daily calibration values as is our usual method, we have averaged the calibration values for the entire month and inserted a quality estimate of C which represents the possible deviation from the monthly value on any particular day.

CALIBRATION DATA
JANUARY,1974

DATE	A	B	C	D
31,000F, V= 2750 Int.= 10, Diff.= 50 Disc.= 1.25, G.= 2				
364	9.6	--	--	-64B
365	--	--	--	--
001	--	--	--	--
002	10.8	--	--	-61B
003	--	--	--	--
004	8.9	--	--	--
005	10.1	29.5	9.1A	-62A
006	9.6	--	--	--
007	9.2	29.0	9.3B	-64B
008	--	29.0	9.4A	-65A
009	8.9	--	--	--
010	10.4	28.5	--	-62B
011	9.3	--	--	-64B
31,000F, V= 2800 Int.= 10, Diff.= 50 Dics.= 1.70, G= 2				
012	9.0	28.0	7.9A	-50A
013	10.2	--	--	--
014	9.4	28.0	8.0A	-51A
015	9.4	29.0	--	-51B
016	8.9	29.0	8.6A	-57A
017	10.4	--	--	-54B
018	11.0	--	--	--

CALIBRATION DATA
FEBRUARY

31,000, V= 2800
Int.=10, Diff.=50
Dics.=1.70, G=2

DATE	A	B	C	D
027	10.3	--	--	--
028	--	--	--	-51B
029	9.8	--	--	-51B
030	8.7	28	8.4B	-55B
031	8.7	--	--	-51B
032	8.8	--	8.5B	-56B
033	9.9	27	7.6B	-47B
034	--	--	--	-51B
035	9.3	--	--	-51B
036	10.6	--	--	--
037	10.3	---	--	--
038	9.2	--	--	--
039	--	--	--	--
040	9.3	27	7.6B	-47B
041	9.0	--	--	--
042	9.3	27	8.4A	-55
043	9.7	27	7.8A	-49A
044	8.9	--	8.3A	-54A
045	8.5	27	8.6A	-57A
046	--	--	--	--
047	--	--	--	--
048	--	--	--	--